4 Environmental Analysis

4.0 ENVIRONMENTAL ANALYSIS

4.1 INTRODUCTION TO ENVIRONMENTAL ANALYSIS

Chapter 4 describes existing (baseline) environmental conditions within the Project area by resource and evaluates potential impacts on these resources that could result from activities associated with the Project and Project alternatives. The environmental resources examined in sections within this Revised Draft Environmental Impact Report (EIR) are listed below. While the sections are identical to those contained in the October 2004 Draft Environmental Impact Statement (EIS)/EIR, the text may have changed in response to public comments and new information provided by the Applicant.

- 4.1.8 Oceanography and Meteorology
- 4.2 Public Safety: Hazards and Risk Analysis
- 4.3 Marine Traffic
- 4.4 Aesthetics
- 4.5 Agriculture and Soils
- 4.6 Air Quality
- 4.7 Biological Resources – Marine
- 4.8 Biological Resources – Terrestrial
- 4.9 Cultural Resources
- 4.10 Energy and Minerals
- 4.11 Geologic Resources and Hazards
- 4.12 Hazardous Materials
- 4.13 Land Use
- 4.14 Noise and Vibrations
- 4.15 Recreation
- 4.16 Socioeconomics
- 4.17 Transportation
- 4.18 Water Quality and Sediments
- 4.19 Environmental Justice
- 4.20 Cumulative Impacts

Issues raised during public scoping and the comment period for the October 2004 Draft EIS/EIR (see Table 1.4-1 at the end of Chapter 1.0, "Introduction") are addressed as indicated for each resource area listed above, as are proposed Applicant measures and additional mitigation measures for identified impacts.

Each Chapter 4.0 resource section includes the following subsections:

- Environmental setting;
- Regulatory setting;
- Significance criteria;
- Impacts analysis, including Applicant measures and mitigation measures for each impact;

- Impacts of alternatives compared with those of the proposed Project.

The analysis of potential cumulative effects in conjunction with other existing or planned projects is described in Section 4.20, “Cumulative Impacts Analysis.”

4.1.1 Baseline Conditions

The analysis of each environmental issue area begins with an examination of the existing physical environmental conditions that may be affected by the proposed Project. The effects of the Project are defined as changes to the existing environmental conditions that are attributable to Project components or operation. The California Environmental Quality Act (CEQA) Guidelines § 15125(a) state in part:

> An EIR must include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the notice of preparation is published. . . from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant. The description of the environmental setting shall be no longer than is necessary to an understanding of the significant effects of the proposed project and its alternatives.

Although not prescribed with such specificity, the National Environmental Policy Act of 1969 (NEPA) also requires a project description.[1]

Baseline conditions in the Project area were identified based on literature reviews, fieldwork, and input from appropriate Federal and State agencies. These conditions (such as existing air quality, population growth trends, and recreational opportunities) allow for characterization and anticipation of Project impacts and form a basis for any future consideration of the Project. Sources for the literature reviews included published technical reports, Internet resources, data from government sources, aerial photographs, and information provided by the Applicant. Where existing information regarding the Project area was insufficient or outdated, surveys and studies were conducted to determine the existing environmental conditions. This work included geotechnical, marine archaeology, land use, cultural resources, terrestrial biological, and wetland surveys.

4.1.2 Regulatory Framework

Existing laws and regulations determine the nature, extent, and legal requirements that allow Project activities and may affect such Project factors as location, duration, footprint, discharges, work practices, and agency cooperation. They may also specify permits and benchmarks necessary for Project authorization or evaluation. Laws, regulations, and permits may come from local, State, or Federal bodies and agencies. Sections 4.2 through 4.19 identify applicable laws and regulations for each issue area.

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[1] See NEPA’s Forty Most Asked Questions at http://ceq.eh.doe.gov/nepa/regs/40/40p3.htm

4.1.3 Significance Criteria

Determination of an impact's significance is derived from standards set by regulatory agencies on the local, State, and Federal levels; knowledge of the effects of similar past projects; professional judgment; and plans and policies adopted by governmental agencies. According to the State CEQA Guidelines § 15382, a significant effect on the environment means "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project . . ." The CEQA Guidelines § 15126.2 also states in part:

> An EIR shall identify and focus on the significant environmental effects of the proposed project. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published . . . Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services.

In this document, the U.S. Coast Guard (USCG), U.S. Maritime Administration (MARAD), and California State Lands Commission (CSLC) have identified "significance criteria" for each environmental issue area that serve as thresholds for determining if a component action will result in a significant adverse environmental impact when evaluated against the baseline. The State CEQA Guidelines § 15064.7(a) defines a threshold of significance (significance criteria) as "an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant."

This document has also been prepared to comply with NEPA, the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] §§ 1500–1508), the Deepwater Port Act, and USCG Implementation Regulations (Commandant's Instructions, National Environmental Policy Act: Implementing Procedures and Policy for Considering Environmental Impacts M16475.1D).

4.1.4 Direct and Indirect Impact Analysis

In accordance with NEPA and the CEQA and their implementing regulations, this document considers the direct and indirect effects of the proposed Project and its alternatives. Impacts are quantified as much as possible:

- *Direct impacts* are those that result from the proposed action and occur at the same time and place. Dispersion of air pollutants from a vessel stack into the atmosphere is an example of a direct effect; and
- *Indirect impacts* are those reasonably foreseeable effects that are caused by the proposed action but that may occur later and not necessarily at the location of the direct effect. For example, removal of vegetation in a waterway may increase the potential for sedimentation at that site or downstream later in the year.

Impact thresholds provide an overall measurement of how the proposed Project and its alternatives could influence the existing environment. The regulations issued by the CEQ to implement NEPA define significance of effects in terms of context and intensity. *Context* refers to the geographic area of impact, which varies with the physical setting of the activity and with each element of the environment analyzed. *Intensity* refers to the severity of the impact. Duration is also considered in the assessment of impacts:

- Temporary – returns to baseline conditions after the activity stops;
- Short-term – returns to baseline conditions on its own within one year of the activity;
- Long-term – returns to baseline conditions after restoration and monitoring; and
- Permanent – never returns to baseline conditions.

For this document, impacts are defined using the four categories described below in Table 4.1-1. Both the CSLC and USCG criteria apply to the class definitions.

Table 4.1-1 Categories of Impacts

Class Definition	CSLC Criteria	USCG Criteria
Class I	Significant adverse impact that remains significant after mitigation	Major, permanent, long-term, or short-term
Class II	Significant adverse impact that can be eliminated or reduced below an issue's significance criteria	Minor, long-term
Class III	Adverse impact that does not meet or exceed an issue's significance criteria	Minor, short-term, or temporary
Class IV	Beneficial impact	Positive, may be major or minor, short- or long-term or permanent

For example, Class I impacts cannot be mitigated to a level below significance criteria. Potential impacts are identified by a bold letter-number designation, e.g., **Impact PS-1** in Section 4.2, "Public Safety: Hazards and Risk Analysis." For each Class I impact, the CSLC and other State permitting agencies would have to make a Statement of Overriding Considerations per the State CEQA Guidelines § 15093 to approve the Project.

4.1.5 Applicant Measures and Mitigation Measures

Applicant measures are incorporated into and modify the Project. The impact analyses are based on the Project as modified. If an analysis concludes that there exists the possibility of a potentially significant impact even after Project modifications are considered, the analysis establishes the appropriate impact class and determines additional required mitigation. Applicant measures included in the Project description are identified by the prefix "AM," e.g., AM PS-1a. Mitigation measures that are specified by the lead agencies to reduce any potential significant environmental impacts remaining after Project modification are identified by the prefix "MM," e.g., MM PS-1e.

Mitigation measures are specific methods to avoid, prevent, minimize, or compensate for an activity's adverse effects. If impacts remain significant after mitigation, i.e., continue to exceed the significance criteria, further measures may be proposed, or the impact may be determined to be significant and not mitigable (Class I).

Examples of types of mitigation measures are listed below (see also State CEQA Guidelines § 15370). The first priorities are avoidance and prevention of impacts; the remaining categories are less rigid:

- *Avoidance* – avoid activities that could result in adverse impacts and avoid certain types of resources or areas considered environmentally sensitive, e.g., coral reefs;
- *Prevention* – Prevent the occurrence of negative environmental impacts;
- *Reduction or Elimination/Minimization* – limit or reduce the degree, extent, magnitude, or duration of adverse impacts;
- *Restoration* – rehabilitate or repair the affected environment; and
- *Compensation* – create, enhance, or protect the same type of resource at another location to compensate for resources lost to development.

A Mitigation Monitoring Program (MMP) has been prepared and is in Chapter 6.0, "Conclusions and Recommendations." To assist in monitoring compliance during Project construction and operations, the MMP includes both the AMs and MMs. The CSLC would adopt the MMP if it were to approve the Project. The Governor of California may also recommend to MARAD additional conditions for the Federal Deepwater Port (DWP) license that would make the proposed Project consistent with coastal zone management, land use plans and policies, and environmental considerations. If the license were approved, such conditions would become part of the Record of Decision, the license, and the MMP.

4.1.6 Evaluation of Alternatives

Impacts from alternatives are compared with those of the proposed Project to determine their relative environmental merit and feasibility. The feasible alternatives evaluated in Chapter 3.0 include no action, a Santa Barbara Channel/Mandalay Shore Crossing/

Gonzales Road Pipeline alternative, a multiple buoy mooring direct regasification concept, other onshore pipeline routes, and other shore crossings and pipeline connection routes.

4.1.7 Underlying Assumptions

The conclusions in this document are based on the analysis of potential environmental impacts and the following assumptions:

- The Applicant or its designated representative (such as Southern California Gas Company [SoCalGas]) will comply with all applicable laws and regulations;
- The Applicant will contract, construct, and operate the Project as described in Chapter 2.0, "Project Description"; and
- The Applicant will implement the measures in its application, in the MMP (see Chapter 6.0), and in supplemental submittals to the USCG, CSLC, and other agencies identified in the MMP.

4.1.8 Oceanography and Meteorology – Environmental Setting

This section provides a description of the marine climatic and oceanographic setting at or near the proposed sites of the floating storage and regasification unit (FSRU) and offshore pipelines to provide an understanding of the factors that are considered in the engineering design. Because oceanographic and meteorological conditions would affect the Project, rather than be affected by the Project, only their setting is discussed—not regulations, significance criteria or impacts, which are discussed for other resources in Chapter 4.

This section describes the weather conditions; air stability; mixing heights; and tidal, current, wind, and wave conditions. Marine water quality parameters such as salinity are discussed in Section 4.18, "Water Quality and Sediments." The potential for tsunamis and beach erosion is discussed in Section 4.11, "Geologic Resources and Hazards." Potential public safety impacts from severe weather or sea conditions are described in Section 4.2, "Public Safety: Hazards and Risk Analysis."

This section also addresses comments received during the public scoping in March 2004 and during the public review period for the October 2004 Draft EIS/EIR. Comments included concerns about whether the Project facilities could be safely designed to the given meteorological and oceanographic conditions in the Project area, whether the FSRU could withstand a 100-year storm that could be encountered during travel from the shipyard to the Cabrillo Port site, and whether the FSRU could withstand a 500-year storm event at the proposed mooring location.

The regulations implementing the Deepwater Port Act (33 CFR § 149.625(a)) require that "each component, except for hoses, mooring lines, and aids to navigation buoys, must be designed to withstand at least the combined wind, wave, and current forces of the most severe storm that can be expected to occur at the deepwater port in any 100-

year period." It should also be noted that the FSRU's moss tanks would be empty (would not contain liquefied natural gas [LNG]) and would not be operating while being towed from the shipyard.

By definition, a 100-year wave event is expected to occur once every 100 years on average over the course of many hundreds of years. However, the estimated 100-year significant wave height (average height of the one-third highest waves) of 24.6 feet (7.5 meters [m]) and peak wave period of more than 16 seconds at the FSRU exceed any waves generated locally by strong northwest winds. The most extreme waves are primarily generated in the deep ocean and propagate through the islands. In addition, the proposed FSRU location, risers, moorings, and subsea pipelines must be designed to withstand tsunamis. CSLC Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS)[2] define expected 100-year wave run-up heights from tsunamis at Port Hueneme to be 11 feet (3.4 m). At the offshore location of the FSRU, the size and intensity of this tsunami would be considerably less than the 100-year wave event. For comparison, 500-year wave run-up heights at Port Hueneme are expected to be 21 feet (6.4 m).

To date, engineering designs are not finalized nor are they required to be until after the MARAD license (or a license with conditions) and CSLC lease would be issued or issued a license with conditions. However, the Applicant would design the FSRU and its mooring system based on 100-year wind/wave sea states with a 2-knot[3] (2.3 mph or 1.03 meters-per-second [m/s]) surface current originating from the most conservative direction. The final design criteria, engineering designs, and analysis will be developed and reviewed in the manner discussed in Section 2.2.2, "Floating Storage and Regasification Unit." The final FSRU design would require final approval from the USCG.

Three nearby wave buoys are National Oceanic and Atmospheric Administration (NOAA) Buoy 46025 (Catalina Ridge) and Coastal Data Information Program (CDIP) Buoys 028 (Santa Monica Bay) and 102 (Point Dume).[4] NOAA Buoy 46025 is approximately 7 nautical miles (NM) (8.05 statute miles or 13 kilometers ([km]) south of the FSRU site;[5] it is the most exposed of the three buoys and has the longest record (1982 to 2004). CDIP Buoy 102 (2001 to 2004) is closest to the FSRU site, approximately 4.9 NM (4.6 statute miles or 9 km) to the northeast across the shipping lanes, and CDIP Buoy 028 (2000 to 2004) is approximately 16 NM (18 statute miles or 30 km) to the east (see Figure 4.1-1).

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[2] CSLC MOTEMS, effective February 6, 2006, Chapter 31F, Division 3, Table 31F-3-8, accessible at http://www.slc.ca.gov/Division_Pages/MFD/MOTEMS/MOTEMS.htm.

[3] 1 knot = 1.15 mile/hour (mph)

[4] Data from these buoys are available at the following websites
- NOAA Buoy 46025: http://www.ndbc.noaa.gov/station_page.php?station=46025;
- CDIP Buoys 102 and 028 (click on buoy): http://cdip.ucsd.edu/?nav=historic&sub=map&xmap_id=9.

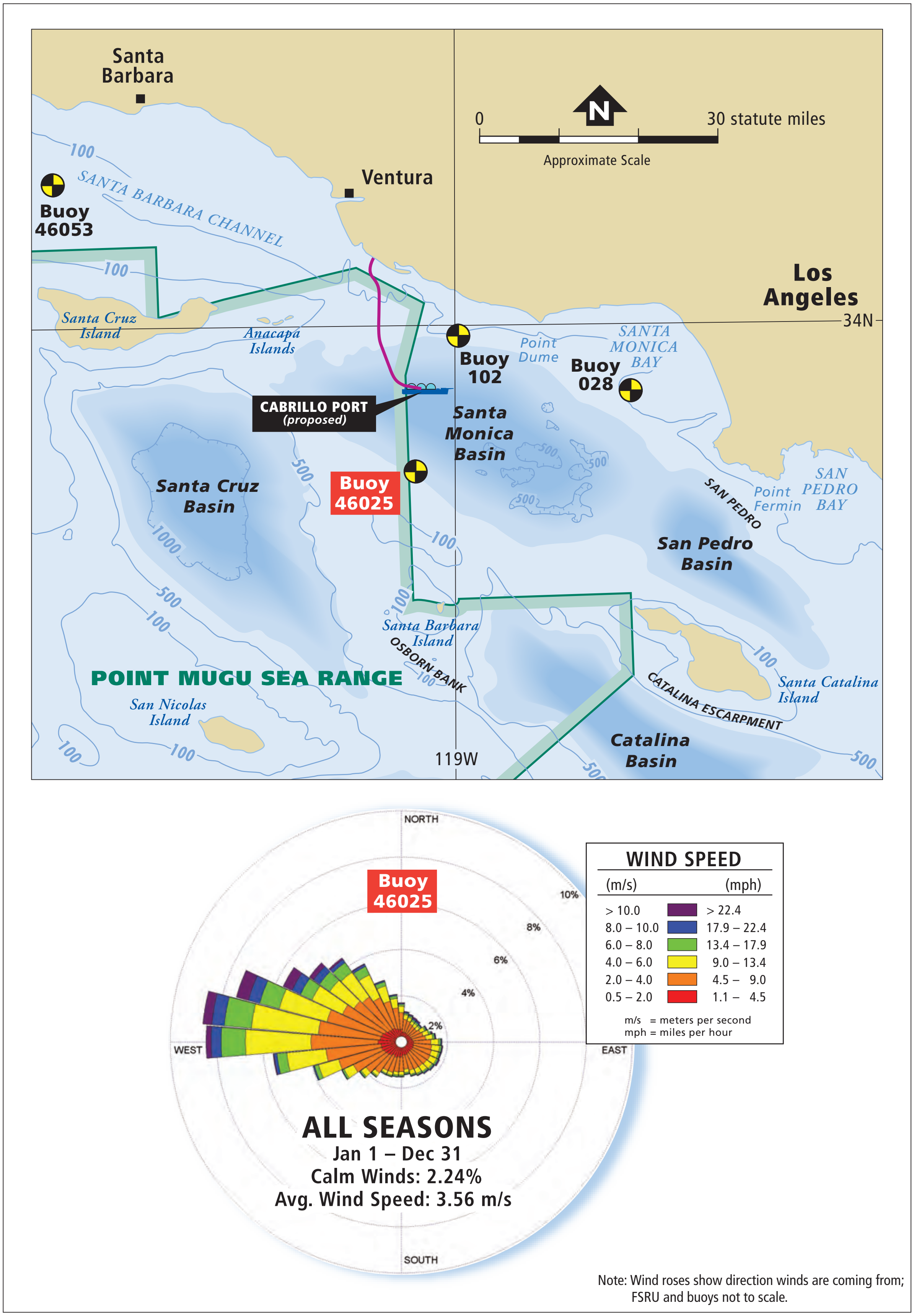
[5] 1 nautical mile = 1.15 statute miles = 2,025 yards

NOAA Buoy 46053 is located in the Santa Barbara Channel, 12 NM (14 statute miles or 22 km) southwest of Santa Barbara and about 46.6 NM (53.6 statute miles or 86.3 km) to the west-northwest from the FSRU's proposed location in the Santa Monica Basin. The October 2004 Draft EIS/EIR did not analyze data from Buoy 46053 because it is more sheltered from large North Pacific wave events than Buoy 46025; the use of Buoy 46053 wave data in any external wave analysis would have resulted in considerably lower 100-year design wave heights for the FSRU site. While the monthly mean wave heights at the two buoys are similar, the maximum wave heights that have been measured at Buoy 46025 are several meters higher than those at Buoy 46053 during the winter months. The wave record at Buoy 46025 is also longer and thus there have been more opportunities to measure waves during a severe winter; therefore, use of these data would provide a statistically more complete depiction of the wave conditions in this area. This conclusion is consistent with summary wave climate plots provided by the National Buoy Data Center for NOAA wave buoys.

Cabrillo Port would be located within the Southern California Bight. The Southern California Bight extends south from Point Arguello to the Mexican border. Within the Southern California Bight are submarine canyons, peaks, and offshore islands. The offshore components of the Project would be located in the Santa Monica Basin. The Santa Monica Basin, in conjunction with the San Pedro Basin (referred to as the *Santa Monica-San Pedro Basin Complex*), is approximately 54 NM (62 statute miles or 100 km) long, 22 NM (25 miles or 40 km) wide, and 3,000 feet (900 m) deep at its maximum depth (see Figure 4.1-1) (Minerals Management Service Pacific Outer Continental Shelf Region 2001). The topography is heterogeneous over the Santa Barbara and San Pedro Channel basin complex, with the physical channel within the basins becoming narrower as depth increases. This blocks regional water flow to an increasing degree with depth and completely blocks it below the deepest sill (Hickey 1992).

4.1.8.1 Circulation and Currents

Circulation in the Southern California Bight is complex (Minerals Management Service Pacific Outer Continental Shelf Region 2001). Regionally, two currents dominate circulation in the Southern California Bight: the California Current flows toward the equator (equatorward) and the Southern California Countercurrent flows towards the North Pole (poleward). Where these two currents meet near the coast and near headlands (Point Conception and Point Arguello), upwelling occurs (California Department of Fish and Game 2002). Upwelling occurs when winds move the surface ocean water away from the shore and rising deeper water replaces the surface water. Because the ocean water is colder at greater depths, this replacement causes the surface water to also become colder (Academic Resources for Computing and Higher Education Services 2004). Wind, river flow, and other local factors also influence currents, but these are weak and episodic.



001883.CA04.09.22.b (Cabrillo folder) 01/03/2006

Figure 4.1-1

NOAA and CDIP Buoy Locations and Annual Wind Rose (1982-2004) for NOAA Buoy 46025

The proposed Cabrillo Port site is at the inshore side of the Southern California Bight, where the mean circulation is counterclockwise. A northward countercurrent, the Davidson Current, exists near the proposed site. This countercurrent is strongest in summer and early fall and weak or even nonexistent in spring (Hickey et al. 2003). The southward California Current flows approximately 50 NM to 80 NM (60 to 90 statute miles or 100 to 150 km) offshore and therefore does not influence the Project site (Hickey 1993).

Currents near the proposed site are typically northward in summer, fall, and winter. Table 4.1-2 summarizes the characteristics of these currents. In spring, there is an onshore flow. These velocity estimates are typically slower than currents measured at the eastern entrance to the Santa Barbara Channel, approximately 16 NM (18 statute miles or 30 km) to the northwest. Flows at Buoy 46025, which is south of the proposed Project, have higher recorded current speeds below the water surface during the spring.

Table 4.1-2 Characteristics of Currents near the Proposed Project

Season	Direction	Surface Speed
Summer	Northward	0.14 knots (0.16 mph or 7 centimeters/second [cm/s])[a]
Fall	Northward	0.019 knots (0.022 mph or 10 cm/s) [a]
Winter	Northward	0.097 knot (0.11 mph or 5 cm/s) [a]
Spring	Onshore	0.06 knot (0.07 mph or 3 cm/s)

[a] Bray et al. 1999.

Oceanographic conditions in the vicinity of the proposed Project shift from upwelling, poleward push and equatorward push on a 20- to 25-day cycle. When winds and the currents are southward, upwelling can occur near Point Conception and near Point Dume. The topography is heterogeneous over the Santa Monica Basin. During upwelling, colder water is found near the coast and across the Santa Barbara Channel. When this occurs, water at the proposed site would flow southward from the Santa Barbara Channel. In the absence of upwelling, currents flow northward at the proposed site. This represents a poleward push. During poleward push, warmer water from the south travels northward. If this current weakens or reverses, an equatorward push can occur. In a push toward the equator, colder water flows from the north, and an equatorward flow occurs past the Project site. During upwelling, poleward push, and equatorward push, currents fluctuate approximately 0.2 knots (0.22 mph or 10.3 cm/s).

In the area of the proposed FSRU, tidal currents vary from 7.5 to 16 feet per minute (0.074 to 0.16 knots or 3.8 to 8.3 cm/s) and generally flow from the northwest to the southeast. In general, the northwest/southeast tidal current ranges in velocity from 4.5 to 8.8 feet per minute (0.044 to 0.087 knots or 2.3 to 4.5 cm/s), with the highest velocities 250 feet (76 m) beneath the surface (Münchow 1998).[6] Recent unpublished observations (Dever 2004) show that tides found near the ocean floor can be much

[6] These current speeds were derived from conventional harmonic analysis and, therefore, do not include the total contribution of internal tides. Internal tides are generated by the interaction of the surface tides with bathymetry.

stronger than those described above. From November 2002 to July 2003, velocities as high as 138 feet per minute (1.4 knots or 70 cm/s) were observed within 49 feet (15 m) of the bottom (656 feet [200 m] total water depth) at the eastern entrance to the Santa Barbara Channel. The design surface current is 2 knots (2.3 mph or 103 cm/s), and the current at depth would be considered in the analysis and design of the riser/mooring and the subsea pipeline. For example, the chain or mooring cable would have to have sufficient tensile strength to withstand the subsea currents.

4.1.8.2 General Wave Climate

The Cabrillo Port area is sheltered from waves from the northwest by Point Conception and the Channel Islands. In addition, the area is partially sheltered from some south swell directions by the Santa Catalina, San Clemente, and Santa Barbara Islands. As a result, the average wave height in the proposed Cabrillo Port area is considerably lower than that seaward of the Channel Islands, but the directional wave spectra (distribution of wave energy with wave direction) at the site is much more complex than that in the open ocean.

The proposed Cabrillo Port and offshore pipeline area would be dominated by waves with periods greater than 10 seconds generated by distant storms (swell). From spring through fall, the dominant swell is generated by Southern Hemisphere storms arriving from the south. Southern swells typically have peak wave heights of 1.6 to 4.9 feet (0.5 to 1.5 m) and peak wave periods of 14 to 20 seconds. During these same months, swells from tropical storms off Mexico, with wave periods of 8 to 17 seconds and 3.3- to 10-foot (1- to 3-m) wave heights, arrive from the south a few times each year.

During winter, the dominant swell is generated by North Pacific storms and arrives at the proposed FSRU area from the west. West swells typically have wave heights of 3.3 to 10 feet (1 to 3 m) and a peak period of 10 to 18 seconds. It is common to have south and west swells present in the proposed Cabrillo Port area at the same time, particularly during spring and fall.

In addition to swell, the proposed Cabrillo Port site is exposed to locally generated wind seas throughout the year, with wave periods less than 8 seconds and typical wave heights of 3.3 to 6.6 feet (1 to 2 m). Strong northwest winds offshore of the Cabrillo Port site, particularly during spring and summer, result in seas arriving from the west. Energetic sea events (waves that are large enough to influence marine operations) can develop in the Cabrillo Port area from the south, preceding the passage of low-pressure weather systems, and from the north to east during Santa Ana wind events.

The overall severity of winter wave conditions in the Cabrillo Port area can vary dramatically from year to year, depending on weather patterns over the North Pacific. The worst winters are associated with strong El Niño periods on the U.S. West Coast, when west-to-east storm paths across the North Pacific are more likely to take a southerly course toward Southern California. Storms that pass near or through Southern California can generate large (greater than 6.6 feet (2 m) and up to 15 feet (4.5 m) in extreme cases) prefrontal wind seas from the south, followed by large (greater than 13 feet [4 m]) swells from the west at the port site. The worst El Niño storm wave scenario on record (1982 to 1983) was characterized by several time periods during which multiple storms arrived in succession, resulting in unusually high wave and swell heights in the proposed FSRU area for many days at a time.

4.1.8.3 Extreme Wave Analysis

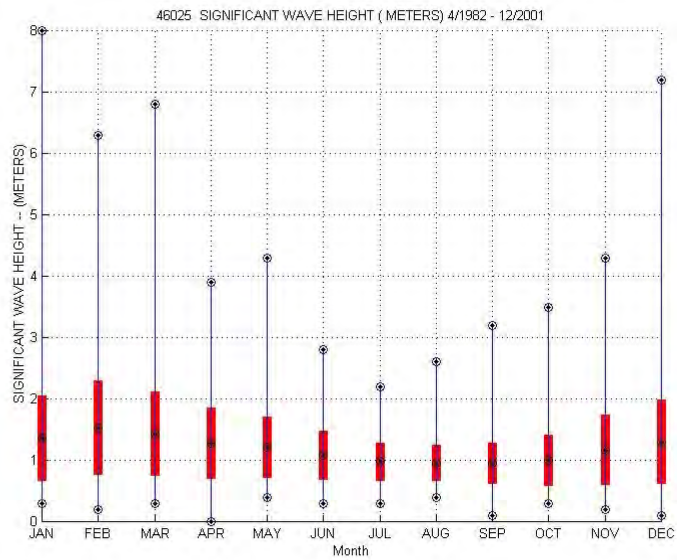
One of the parameters used to analyze waves is significant wave height (H_s), an engineering parameter that describes the average height of the one-third highest waves, not the largest individual wave that is expected to occur during a storm (which is roughly double the H_s value). The probability of larger extreme waves is either estimated directly from H_s or implicitly derived from it as part of the standard procedures used in ocean and coastal engineering design practice. The data presented in this section are not intended to portray the maximum height of waves in the area but, rather, the significant wave height. Significant wave height is a statistical description of the sea state from which maximum heights can be estimated. It is standard engineering practice to use these values.

Larger waves may occur due to wave refraction around the islands. Wave refraction around the islands was included in the wave climate analysis in the October 2004 Draft EIS/EIR. Island "blocking" or "sheltering" are terms commonly used in engineering practice to describe the combined effect of waves dissipating on the island coastlines as well as the refraction of waves around the islands. It is widely accepted that the islands offshore of Southern California result in an overall reduction of wave energy in the Southern California Bight. Scientific literature on this topic dates back to the 1950s (Emery, 1958; O'Reilly, 1993).

The largest storm on record near the Port site area occurred on January 17 and 18, 1988. NOAA Buoy 46025 measured a maximum significant wave height (average height of the one-third highest waves) of 26 feet (8 m), with a peak wave period of 18 seconds (see Figure 4.1-2). The proposed Cabrillo Port site, located several miles to the north of the buoy location, benefits from additional island sheltering compared with the buoy site. The Applicant's external wave hindcast and analysis for this event produced a significant wave height at the FSRU site of 25 feet (7.5 m), with a peak wave period of 16.8 seconds and a peak wave arrival direction from the southwest. The Applicant used commonly accepted methods and practices to derive extreme wave statistics. The Applicant's wave hindcast results appear reasonable and consistent with historical observations in the Southern California region.

Storm build-up times used in the Applicant's wave hindcast model appropriately estimated the storm size. The wave hindcast model used finite calculation "time steps" (much shorter than four hours) and output wave information at prescribed times (every four hours in this case) for later analysis. The four-hour increment in wave model output does not limit the actual duration of the hindcast storms or the time periods over which larger waves can occur.

Figure 4.1-2 NOAA Wave Climate Summary Plot for NOAA Buoy 46025



Source: http://www.ndbc.noaa.gov/images/climplot/46025_wh.jpg

1 The characteristics of the Applicant's estimated 100-year wave events at the proposed
2 Cabrillo Port site and shoreward end of the pipeline are provided in Table 4.1-3. A 100-
3 year wave event represents an event that has the probability of occurring once every
4 100 years. However, that does not mean that it will occur every 100 years; it could
5 occur in two successive years. The term 100-year event simply states a probability of
6 the occurrence of an event.

Table 4.1-3 Applicant-Calculated Significant Wave Heights

Location	Significant Wave Height (feet/meters)	Peak Period (seconds)	Peak Direction (degrees True)
Port	24.6 / 7.5	16.8	202.5 to 247.5
Pipelines	12.5 / 3.8	14	202.5 to 247.5

7 The peak direction is the true compass heading from which the waves arrive. The two
8 offshore pipelines hindcast location is 34.13º N, 119.19º W, in a 39-foot (12-m) water
9 depth, representing the shallowest location where the twin pipelines might enter the sea
10 bottom after horizontal directional boring (HDB) from shore.

11 4.1.8.4 Operational Wave Conditions

12 The operational wave conditions at the proposed Cabrillo Port site are characterized in
13 part by the Applicant's hindcast estimate of the one-year return period of waves and by
14 historical measurements from three buoys in the port area. The Applicant's estimated
15 one-year return period wave height is 12.8 feet (3.9 m). A wave event of this size is
16 most likely to have a peak period of 11 to 14 seconds and a peak arrival direction of
17 202.5 to 247.5 degrees (southwesterly).

Table 4.1-4 summarizes the average number of days per year in which significant wave heights of 6.5, 8.2, and 9.8 feet (2, 2.5, and 3 m) were equaled or exceeded at the three buoy locations. In addition, the table shows the number of days exceeded in the years with the most frequent, average, and least exceedances of wave heights for each buoy.

Table 4.1-4 Numbers of Days Per Year in which Waves Exceed Specified Heights at Buoys Located in the Vicinity of the Proposed Site of the FSRU

Buoy	Years	Number of Days in which Waves Exceeded 6.5 Feet (2 Meters)			Number of Days in which Waves Exceeded 8.2 Feet (2.5 Meters)			Number of Days in which Waves Exceeded 9.8 Feet (3 Meters)		
		Average	Most	Least	Average	Most	Least	Average	Most	Least
NOAA 46025	1982 to 2004	24	74	7	9	39	1	3	21	0
CDIP 028	2000 to 2004	10	12	8	3	5	2	1	1	1
CDIP 102	2001 to 2004	9	13	7	3	5	1	1	1	1

The years are defined from June 1 to May 31. Buoys 46025, 028, and 102 had sufficiently complete records to provide exceedance estimates for 16, 4, and 3 years, respectively. The worst year on record (74 days with wave heights exceeding 6.6 feet [2 m]) was the El Niño winter of 1982 to 1983. In contrast, the best years on record had only approximately seven days with wave events exceeding 6.6 feet (2 m). The table shows that exceedance of the estimated one-year return period wave height of 12.8 feet (3.9 m) is likely to occur many times during a severe El Niño winter in Southern California but would rarely occur during non-El Niño winters. All the types of wave events described above can potentially produce waves exceeding 6.5 feet (2 m).

4.1.8.5 Meteorology and Climate

The climate of the Northern Channel Islands is characterized by mild winters and dry summers and is dominated by a strong and persistent high-pressure system known as the *Pacific High*. The Pacific High shifts northward or southward in response to seasonal changes or cyclonic storms. The Pacific High influences the presence of temperature inversions. The coast has early morning southeast winds (offshore), which shift to the northwest as the day progresses. In late spring and early summer, the northwest winds transport cool, humid marine air onshore, causing frequent fog and low clouds on the coast at night and in the morning (California Department of Fish and Game 2002).

Mean air temperatures measured at NOAA Buoy 46025 at about 13.1 feet (4 m) above the surface from April 1982 to December 2001 ranged from 57º Fahrenheit [F] to 65.1º F (13.9º Celsius (C) to 18.4º C), with a low of 41.9º F (5.5º C) and a high of 79.7º F (26.5º C) (National Buoy Data Center 2003) (see Table 4.1-5). Mean sea surface temperatures measured at about 2.0 feet (0.6 m) below the surface during this same period ranged from 58.3º F (14.6º C) to 68.2º F (20.1º C). Although the air temperatures cover a wider range and can change more quickly throughout the day, further review of the Buoy 46025 data (1982 to 2004) shows that most of the time (about 89 percent) the difference between the air and sea temperatures is less than 4.5º F (2.5º C) and that most of the time (about 83 percent) the water is warmer than the air.

Table 4.1-5 Summary of Meteorological Ocean Conditions at Buoy 46025

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Air Temperature (4/82 to 12/01) (°C)													
Mean	14.2	13.9	14.0	14.4	15.3	16.3	17.7	18.4	18.4	17.8	16.2	14.5	15.9
Maximum	22.4	24.0	24.7	26.4	22.2	23.7	24.2	23.7	24.9	26.5	23.9	22.5	26.5
Minimum	8.4	7.3	8.9	9.1	10.9	11.5	13.4	13.1	14.1	12.8	10.8	5.5	5.5
Sea Temperature (4/82 to 12/01) (°C)													
Mean	14.7	14.6	14.7	15.2	16.5	17.9	19.4	20.1	19.9	19.0	17.1	15.3	17.0
Maximum	17.9	18.4	19.7	21.2	21.7	22.2	24.9	24.8	23.5	22.8	21.0	18.7	24.9
Minimum	11.8	11.8	12.2	11.5	12.8	13.3	16.0	16.4	16.0	15.2	12.8	12.4	11.5
Air minus Sea Temperature (4/82 to 12/01) (°C)													
Mean	-0.5	-0.7	-0.8	-0.7	-1.3	-1.6	-1.6	-1.7	-1.4	-1.1	-0.9	-0.8	-1.1
Maximum	7.2	8.3	7.7	8.6	3.9	3.8	3.8	2.0	6.4	6.2	6.3	8.5	8.6
Minimum	-6.0	-6.6	-6.3	-5.7	-4.5	-7.9	-5.2	-7.4	-5.5	-5.1	-6.5	-9.0	-9.0
Dew Point Temperature (5/9 to 10/00) (°C)													
Mean	12.0	11.0	9.9	12.1	13.3	13.5	15.0	15.7	15.1	14.6	12.9	9.3	13.4
Maximum	15.9	14.9	14.4	17.9	18.9	18.9	18.9	21.0	20.5	19.1	18.5	15.0	21.0
Minimum	-0.8	2.9	-1.1	3.3	4.8	4.0	11.9	11.6	10.3	6.5	-0.7	-7.9	-7.9
Air minus Dew Point Temperature (5/9 to 10/00) (°C)													
Mean	1.7	2.1	3.2	2.2	2.1	2.3	2.3	1.8	2.3	2.3	2.6	5.3	2.4
Maximum	16.7	10.3	17.3	15.8	10.4	9.6	6.0	5.6	8.2	15.6	16.4	27.1	27.1
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sea Level Pressure (4/82 to 12/01) (millibars)													
Mean	1,018.3	1,017.3	1,016.1	1,015.0	1,013.9	1,013.0	1,013.4	1,013.0	1,012.1	1,014.3	1,016.7	1,018.1	1,015.1
Maximum	1,031.5	1,028.9	1,025.6	1,027.2	1,023.3	1,022.2	1,021.2	1,020.4	1,020.7	1,023.4	1,028.9	1,032.1	1,032.1
Minimum	988.9	991.6	992.7	1,003.6	1,005.8	1,001.5	1,005.6	1,002.9	1,001.3	1,001.0	1,000.5	998.9	988.9

Table 4.1-5 Summary of Meteorological Ocean Conditions at Buoy 46025

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Average Wind Speed (4/82 to 12/01) (knots)													
Mean	7.5	8.7	7.7	7.9	6.8	6.0	5.6	5.6	5.9	6.1	7.1	7.8	6.9
Maximum	33.0	36.0	32.7	36.5	37.5	25.1	19.6	19.8	22.4	32.9	30.5	36.9	37.5
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peak Wind Gust (4/82 to 12/01) (knots)													
Mean	9.5	11.0	9.9	9.9	8.8	7.8	7.4	7.3	7.7	8.0	9.1	10.0	8.9
Maximum	46.1	44.3	43.0	45.3	47.8	30.1	23.7	27.2	29.7	41.4	42.2	47.0	47.8
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hourly Peak Wind Gust (11/97 to 12/01) (knots)													
Mean	12.1	14.8	12.3	13.1	10.3	9.2	8.7	8.6	8.8	9.3	11.3	12.4	10.9
Maximum	37.3	47.0	40.4	45.1	36.0	27.4	19.8	22.9	20.6	29.0	37.1	40.0	47.0
Minimum	0.8	0.8	1.4	1.6	0.8	1.2	1.4	1.7	1.2	1.6	1.0	1.0	0.8
Significant Wave Heights (4/82 to 12/01) (meters)													
Mean	1.4	1.5	1.4	1.3	1.2	1.1	1.0	1.0	1.0	1.0	1.2	1.3	1.2
Maximum	8.0	6.3	6.8	3.9	4.3	2.8	2.2	2.6	3.2	3.5	4.3	7.2	8.0
Minimum	0.3	0.2	0.3	0.0	0.4	0.3	0.3	0.4	0.1	0.3	0.2	0.1	0.0
Average Wave Period (4/82 to 12/01) (seconds)													
Mean	7.1	7.1	6.8	6.2	6.1	6.0	6.0	5.8	6.0	6.2	6.3	6.7	6.4
Maximum	15.2	14.5	12.5	13.4	12.8	11.3	11.4	14.3	12.9	12.5	12.2	12.8	15.2
Minimum	3.0	2.9	3.5	0.0	3.2	3.1	3.8	3.0	3.3	2.9	2.7	2.6	0.0
Dominant Wave Period (4/82 to 12/01) (seconds)													
Mean	12.6	12.4	12.3	11.0	10.8	11.2	11.6	11.3	11.5	11.8	11.7	11.8	11.6
Maximum	25.0	25.0	25.0	25.0	25.0	20.0	20.0	25.0	25.0	25.0	25.0	25.0	25.0
Minimum	2.3	2.9	2.9	0.0	2.7	2.6	3.4	2.6	2.6	2.7	2.5	2.3	0.0

Winds

Sea breezes are generally from the west, west-northwest, and northwest, and occur about 44 percent of the time throughout the year (see Figure 4.1-1 above, which includes the annual wind rose on a map illustrating the buoy locations in the vicinity of the FSRU); however, there are seasonal variations (see Figure 4.1-3). Based on weather data collected from NOAA Buoy 46025 from 1982 to 2004, summer winds tend to be the lightest, with an average wind speed of 5.1 mph (2.29 m/s) blowing predominantly from the west. During fall and particularly during the winter, the region is subject to Santa Ana winds, which are northeasterly winds that blow in from the inland desert regions. Santa Ana wind speeds typically range from 15 to 20 mph (6.7 to 8.9 m/s), although they can reach 60 mph (26.8 m/s) (California Department of Fish and Game 2002). Spring winds are generally calmer than in the winter, dropping from an average wind speed of 9.2 mph (4.11 m/s) during December through February to an average of 7.6 mph (3.88 m/s) from March through May. During spring, wind directions also return to a summer pattern dominated by winds from the west and northwest.

From April 1982 to December 2001 at Buoy 46025, the maximum average wind speed was 43.1 mph (19.3 m/s), and the maximum peak wind gust was 55 mph (24.6 m/s) (see Table 4.1-5). The maximum hourly peak gust was 55.1 mph (24.6 m/s) (National Buoy Data Center 2003).

Visibility

Although there are no visibility data available for the specific Project area, Table 4.1-6 summarizes data from Point Mugu, which is located approximately 14 miles (22.5 km) from the FSRU. This dataset covers the years 1946 to 1993 and is the longest and most complete dataset for the vicinity of the Project. Although these data are for an onshore location, they are representative of the visibility conditions that could occur at the proposed FSRU location. The data in the table represent that percentage of time in which visibility is greater than the miles listed. In general, for objects greater than 10 miles (16 km) away, the greatest visibility (the least fog layer or haze, highlighted in light gray in the table) occurs in winter and diminishes from spring through summer. The least visibility for objects that far away (highlighted in dark gray in the table) occurs from July through September, when weather conditions are more likely to include a persistent deep marine layer and high humidity. Visibility greater than or equal to 10 miles (16 km) varies from close to 20 percent of the time in July, August, and September to between about 49 percent and 50 percent of the time in December, January, and February. Given that the FSRU would be more than 10 miles (16 km) offshore, it would more likely be visible in winter than in summer, but still less than about half of the time.

As shown in Table 4.1-6, there is a steady decrease in the relative number of clear days as spring progresses into summer. The table also shows that low visibilities (for all distances less than about 4 miles) are most frequent in September and October during weak offshore conditions. However, these months also have some very clear days.

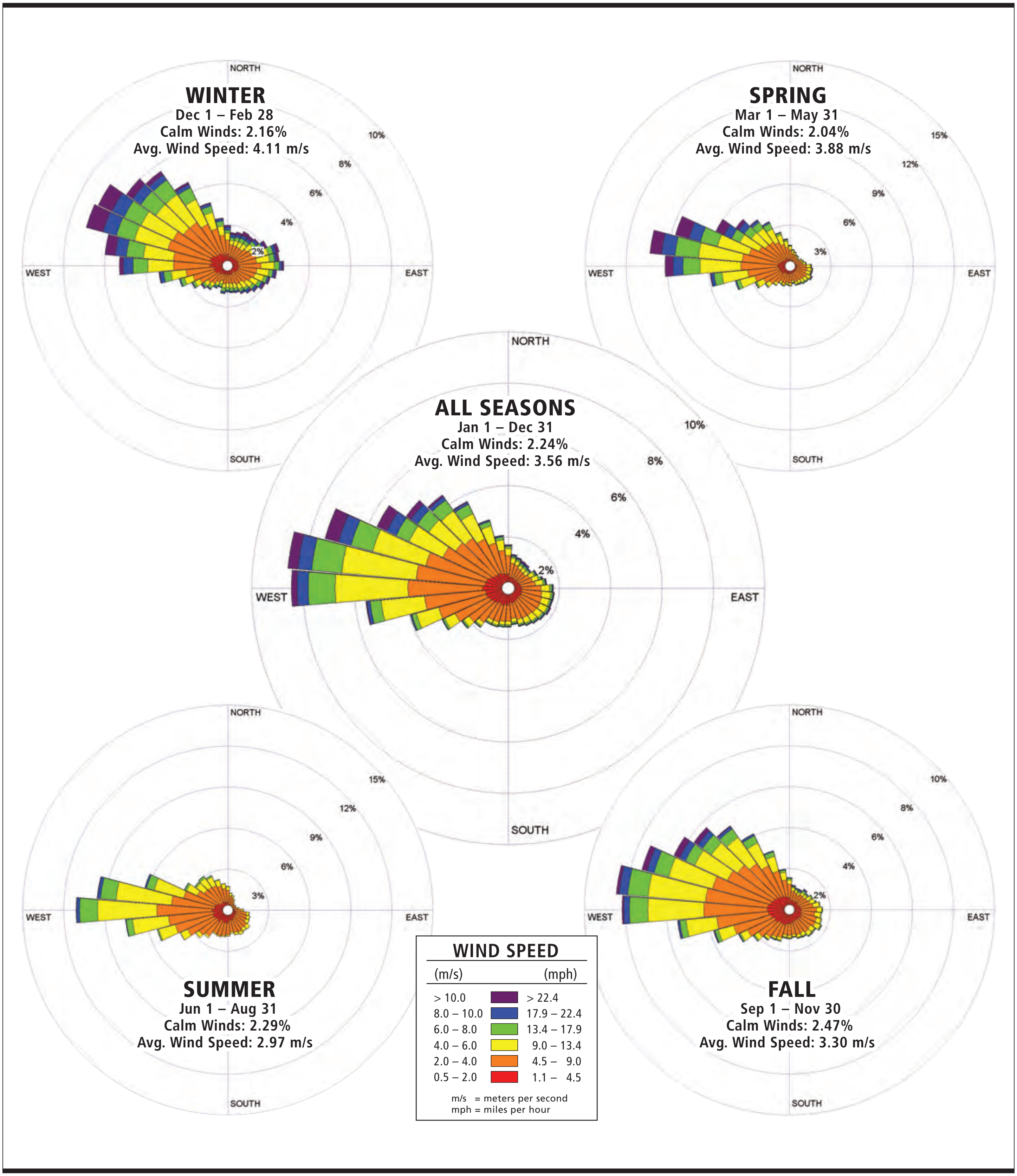


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Figure 4.1-3

Wind Speed and Direction (1982 – 2004) for NOAA Buoy 46025

Very good visibility (greater than 10 miles) occurs less frequently in July and August due to persistent deep marine layers with high humidity, but these months also experience relatively fewer occurrences of very poor visibility. In other words, in mid-summer, visibility is usually somewhat limited but not frequently very low, while in the fall, visibility is more variable with higher frequencies of very low visibility and very good visibility. From a "visible from land" point of view, the facility would be least often seen (according to Table 4.1-6) in summer and most often in winter. From a "visible from an approaching vessel" point of view (short range), poor visibility occurs most frequently in the fall and least frequently in the spring.

Visibilities less than 0.25 mile (0.4 km) are likely to slow marine traffic and interfere with navigation. Visibility would be expected to be greater than 0.25 mile (0.4 km), however, 97.4 percent to 99.2 percent of the time.

Table 4.1-6 Visibility Distances by Month at Point Mugu

Visibility Threshold (statute miles)	Month												
	Jan (%)	Feb (%)	Mar (%)	Apr (%)	May (%)	Jun (%)	Jul (%)	Aug (%)	Sep (%)	Oct (%)	Nov (%)	Dec (%)	Ann (%)
≥ 10	49.7	49.1	48.5	44.5	35.6	29.3	21.0	19.9	23.0	30.2	44.4	49.1	36.9
≥ 6	77.9	75.4	79.7	76.6	68.1	62.6	54.6	52.7	55.4	58.9	73.9	78.3	67.7
≥ 5	83.4	81.5	86.3	84.6	77.9	73.5	67.6	65.5	66.7	67.9	79.7	83.1	76.4
≥ 4	87.3	85.5	90.2	89.1	84.0	80.4	76.5	74.8	74.5	74.3	83.9	86.0	82.1
≥ 3	91.0	89.7	93.2	92.8	89.3	86.7	84.9	83.2	82.3	82.3	89.0	89.8	87.8
≥ 2.5	92.2	91.1	94.2	94.0	91.6	89.5	88.0	86.2	85.0	84.5	90.5	91.1	89.8
≥ 2	94.7	93.7	96.2	95.9	95.1	93.7	92.3	91.2	89.7	89.2	93.0	93.7	93.2
≥ 1.5	95.8	94.8	97.0	96.7	96.6	95.5	94.3	93.3	91.8	91.7	94.3	95.0	94.7
≥ 1.25	95.8	95.0	97.1	96.9	96.8	95.7	94.5	93.5	91.9	92.0	94.5	95.2	94.9
≥ 1	97.4	96.3	98.0	97.7	98.2	97.4	96.6	95.6	94.4	94.1	96.3	96.6	96.5
≥ 0.75	97.7	97.0	98.3	98.1	98.6	98.0	97.4	96.4	95.3	95.0	96.8	97.2	97.1
≥ 5/8	97.7	97.1	98.3	98.1	98.6	98.1	97.4	96.5	95.3	95.1	96.8	97.3	97.2
>0.5	98.3	97.6	98.7	98.5	99.1	98.8	98.3	97.6	96.6	96.3	97.4	97.8	97.9
≥ 5/16	98.4	97.8	98.9	98.6	99.3	99.0	98.6	97.9	96.9	96.4	97.6	98.0	98.1
≥ 0.25	98.8	98.4	99.2	99.1	99.6	99.5	99.2	98.8	98.0	97.4	98.1	98.4	98.7
≥ 0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: International Station Meteorological Climate Summary 1995. Visibility statistics were derived from the archived dataset contained in the data from Point Mugu (34º07' N, 119º07' W).

Note: Light gray indicates the greatest visibility; dark gray indicates the least visibility.

The Naval Air Warfare Center Weapons Division Point Mugu, Sea Range User's Web is a source for weather data for both Point Mugu and San Nicholas Island. The station on San Nicholas Island is located approximately 45 miles (72 km) to the southwest of the proposed FSRU location. The dataset in Table 4.1-7 is relevant for analyzing visibility conditions that may be encountered by LNG carriers approaching the FSRU. This issue is discussed in Section 4.3, "Marine Traffic."

Table 4.1-7 Visibility Frequency (Percent) at Point Mugu (PM) and San Nicholas Island (SNI)

Visibility Threshold (statute miles)		Month												
		Jan (%)	Feb (%)	Mar (%)	Apr (%)	May (%)	Jun (%)	Jul (%)	Aug (%)	Sep (%)	Oct (%)	Nov (%)	Dec (%)	Ann (%)
≥10	PM	49.7	49.1	48.5	44.5	35.6	29.3	21.0	19.9	23.0	30.2	44.4	49.1	**36.9**
	SNI	64.6	63.3	65.6	56.5	43.9	38.0	24.9	27.8	35.7	46.1	59.8	62.6	**48.5**
≥6	PM	77.9	75.4	79.7	76.6	68.1	62.6	54.6	52.7	55.4	58.9	73.9	78.3	**67.7**
	SNI	84.5	83.5	86.2	83.8	75.0	69.3	60.6	64.1	69.5	75.8	83.1	83.0	**76.2**
≥3	PM	91.0	89.7	93.2	92.8	89.3	86.7	84.9	83.2	82.3	82.3	89.0	89.8	**87.8**
	SNI	90.9	91.3	94.5	94.7	91.4	88.6	87.0	88.2	90.3	92.3	93.0	91.5	**91.1**
<1	PM	2.6	3.7	2.0	2.3	1.8	2.6	3.4	4.4	5.6	5.9	3.7	3.4	**3.5**
	SNI	6.2	5.7	3.1	2.7	4.1	5.2	6.8	5.6	3.9	4.2	3.8	5.7	**4.7**
<0.25	PM	1.7	2.4	1.3	1.5	0.9	1.2	1.7	2.4	4.4	3.7	2.6	2.2	**2.1**
	SNI	4.9	4.4	2.2	2.0	2.8	3.3	4.5	3.4	2.8	3.0	2.8	4.5	**3.4**

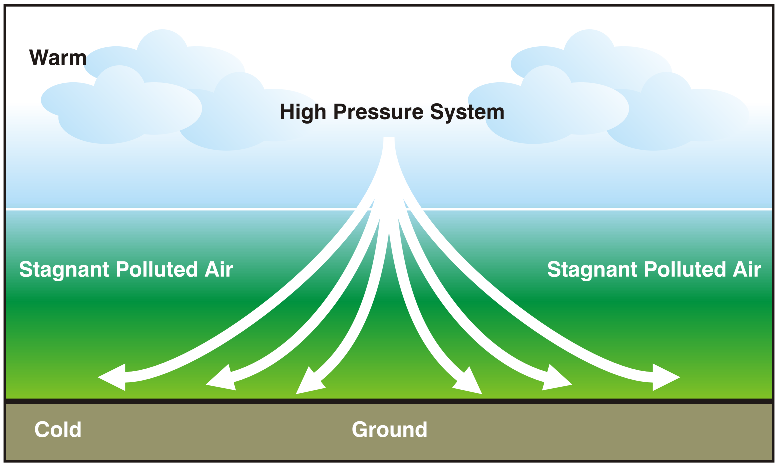
Source: Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, Sea Range User's Web: http://www.nawcwpns.navy.mil/~pacrange/RANGEWEB/section9/sect9c.html.

Air Stability and Mixing Height

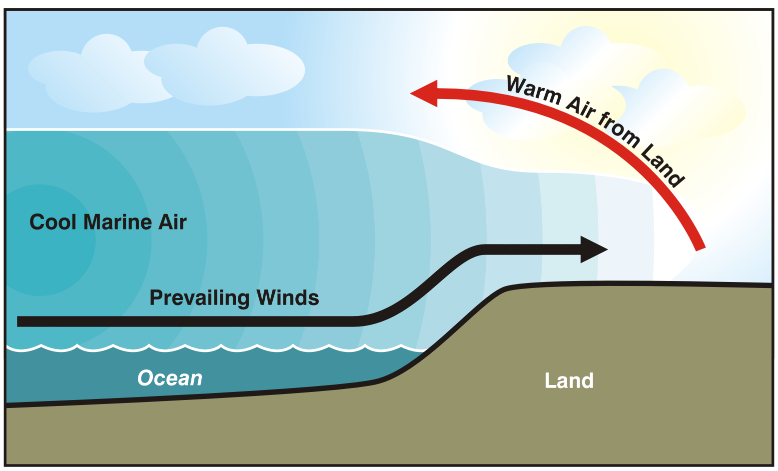
Stability is an atmospheric characteristic that affects air mixing. If the atmosphere is less stable, turbulence increases and the upper and lower atmosphere mix. Mixing height is measured at the distance from the ground to the atmospheric layer, where convection and turbulence promote mixing. If there is a combination of a high mixing height, unstable conditions, and moderate to high wind speeds within the mixed layer, then ventilation and dispersion are good (Minerals Management Service Pacific Outer Continental Shelf Region 2001).

Atmospheric stability affects pollutant concentrations in the region by regulating the amount of air mixing, horizontally and vertically. Increased atmospheric stability restricts mixing and is generally associated with low wind speeds. During these conditions, temperature inversions typically cap pollutants below them. In inversions, a layer of warmer air lies above cooler air near the ground surface, which can prevent the upward flow of air, as shown on Figure 4.1-4.

According to atmospheric soundings at Vandenberg Air Force Base in Santa Barbara County, surface inversions occur from 0 to 500 feet (0 to 152 m) during winter and subsidence inversions occur (1,000 to 2,000 feet [305 to 610 m]) during summer. Vertical dispersion of pollutants generally does not occur when there is an inversion close to the surface and there is a large temperature gradient from the base of the inversion to its top. During summer along the California coast, subsidence inversions are common and are one of the principal causes of air stagnation and poor air quality (Minerals Management Service Pacific Outer Continental Shelf Region 2001). During public scoping, concern regarding the effects that an inversion would have on the dispersion of an LNG release was raised. This issue is addressed in Section 4.2.6, "Public Safety Risk Analysis Process."



Example of a High Pressure Inversion



Example of a Marine Inversion Layer

CABRILLO PORT LNG DEEPWATER PORT

Figure 4.1-4

Inversion Layers

SOURCE: From http:\\www.csun.edu (Entrix 2004).

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